

UNCLASSIFIED

AD NUMBER

AD819822

NEW LIMITATION CHANGE

TO

Approved for public release, distribution  
unlimited

FROM

Distribution authorized to U.S. Gov't.  
agencies only; Administrative/Operational  
Use; JUL 1967. Other requests shall be  
referred to Naval Civil Engineering  
Laboratory, Port Huenum, CA.

AUTHORITY

usncbc ltr, 24 oct 1974

THIS PAGE IS UNCLASSIFIED

**AD81 9822**

**Technical Note N-910**

**CONSTRUCTION AND PRELIMINARY EVALUATION OF AN  
ENVIRONMENTAL TEST CHAMBER**

**by**

**Howard A. Porte, Ph. D.**

**July 1967**

**Internal Working Paper**

Each transmittal of this document outside the agencies  
of the U. S. Government must have prior approval of  
the Naval Civil Engineering Laboratory.

**NAVAL CIVIL ENGINEERING LABORATORY  
Port Hueneme, California**

CONSTRUCTION AND PRELIMINARY EVALUATION OF AN ENVIRONMENTAL  
TEST CHAMBER

Technical Note N-910

Z-R011-01-01-035

by

Howard A. Porte, Ph. D.

ABSTRACT

Details of construction of an environmental wet test chamber are presented. Preliminary test results are reported for mild steel in a salt water environment. It is recommended that further tests be conducted to determine the feasibility of using this apparatus in accelerated tests for coatings.

Each transmittal of this document outside the agencies of the U. S. Government must have prior approval of the Naval Civil Engineering Laboratory.

## INTRODUCTION

The U. S. Naval Civil Engineering Laboratory is involved in the evaluation of coatings used by the Naval Shore Establishment. The Laboratory conducts a continuous program of testing coatings in service at field installations. However this type of testing often involves exposure of coatings over long periods of time, many years. It would be desirable to evaluate coatings in an accelerated test which could be performed in much shorter times. Although numerous accelerated test methods<sup>1</sup> are in use for predicting the performance of paints and coatings in atmospheric environments, as yet no completely satisfactory method has been developed. The main shortcoming of most accelerated methods is the unknown degree of correlation between the results of a laboratory test and the actual service life in a natural environment.

Recent U. S. Naval Air Engineering Center reports describe an environmental wet test chamber which gives good reliability and can be constructed at a relatively inexpensive cost.<sup>2,3</sup> The test chamber was successfully used at NAECC to evaluate thin film compounds but it is conceivable that with slight modifications it could be used to evaluate the performance of paints or coatings on metals and alloys. This wet test chamber, slightly modified, was constructed and preliminary tests of uncoated steel specimens were performed.

## CONSTRUCTION AND OPERATION OF APPARATUS

The apparatus can be assembled from relatively inexpensive parts and is shown in Figure 1. The essential parts are:

1. A glass jar, 12 inches in diameter by 12 inches high.
2. Drive motor. A synchronous one rpm AC motor was used with appropriate gears so that the drive shaft rotated at 1/3 rpm.
3. A spray nozzle. The nozzle consisted of 2 standard glass eye droppers mounted in rubber stoppers and held in position on a specially fabricated tripod stand. The distance between the tips of the droppers was varied experimentally until a suitable spray pattern was obtained.
4. A tripod stand. The stand was made of Lucite. The tripod stand and spray nozzle are shown in Figure 2. Air is forced down the medicine dropper held in the vertical position and the liquid which comprises the spray is pulled up into the horizontal dropper. The horizontal dropper is held by a bracket which is movable and can be adjusted to obtain the proper spray. The dimensions of the tripod stand are shown in Figure 3.
5. A turntable. The turntable was fabricated from 3/4 inch thick, Lucite. It was made 10-1/2 inches in diameter and contained a hole in the

center for the drive shaft and 9 equally spaced holes around the edge to contain the specimen holders. The turntable is shown in Figure 4.

6. The specimen holders. These consisted of small glass jars with the bottoms sawed off and with holes cut in the plastic screw tops. The glass jars mounted in the turntable are shown in Figure 5. A specimen holder with its top removed and a specimen are shown in Figure 6.

In operation, two liters of salt water were placed in the jar and a Tygon tube extending from the horizontal eye dropper dipped into the reservoir of salt water. The air supply was the normal laboratory compressed air supply. A rubber hose was connected through a flow regulator to the vertical medicine dropper. An air flow of 20 liters per minute corresponds to a flow of fluid of about 1300 ml. per hour. This produced a fine spray which was suitable for the experiments.

The salt water used in these experiments was obtained from a well located approximately 100 yards from the Pacific Ocean at Port Hueneme, California. The analysis of this water is given in Table 1.

Table 1. Major Constituents of Salt Water

Ion	ppm
<u>Anion</u>	
Cl <sup>-</sup>	18173
SO <sub>4</sub> <sup>--</sup>	2751
HCO <sub>3</sub> <sup>-</sup>	211
F <sup>-</sup>	1.3
NO <sub>3</sub> <sup>-</sup>	1
<u>Cation</u>	
Na <sup>+</sup>	9890
Ca <sup>++</sup>	1411
Mg <sup>++</sup>	627
K <sup>+</sup>	401
<u>Balance</u>	
B	3.5
SiO <sub>2</sub>	15
Total Solids	35654

## **EXPERIMENTAL**

In order to check out the operation of the apparatus, preliminary tests were conducted on uncoated mild steel specimens. The material, SAE 1010 steel, was cut from Q-panels obtained from the Q-Panel Company, Cleveland, Ohio. The diameter of the specimens was 2.10 inches but with the specimen holders in place the diameter exposed was 1.62 inches with an area of 2.06 square inches. The specimens were exposed to a salt-spray environment and were withdrawn from the apparatus at hourly intervals. Upon removing a specimen from the apparatus a blank specimen holder was inserted in its place and the removed specimen was washed with deionized water and stored in a desiccator.

## **RESULTS**

The effect of exposing mild steel to a salt-spray atmosphere in the experimental wet test chamber for periods from 1 to 7 hours is shown in Figure 7 and 8. Visible corrosion can be detected as early as after a 1 hour exposure and the amount of corrosion product on the surface increases with time of exposure so that after 7 hours exposure the surface is almost completely covered with corrosion products. A photomicrograph of a specimen which was removed after a 1 hour exposure is shown in Figure 9. It appears that corrosion begins at specific sites on the surface and the area of corrosion spreads from these sites. The sites of corrosion are seen to be of varying size indicating that certain sites are more active for corrosion to begin than others. It can be seen that the surface does not become covered uniformly with corrosion product but rather certain areas become corroded rapidly and the corrosion then spreads to other less affected areas.

## **FINDINGS**

1. The observable advantages of the chamber over other commercially available tests are: (a) the specimens are easily accessible for observation or replacement during a test and it is not necessary to stop the apparatus or disturb other specimens, (b) any aqueous environment--salt water, plain tap water, etc.--can be used, and (c) the apparatus can be readily constructed from inexpensive material.
2. Uncoated mild steel showed visible signs of corrosion after one hour exposure to a salt spray atmosphere in the environmental wet test chamber.

## **RECOMMENDATIONS**

1. It is recommended that additional tests be made on coated samples in this chamber in order to determine the feasibility of this apparatus as an accelerated test method for coatings.

#### **ACKNOWLEDGMENTS**

The assistance of M. Pacheco and C. Mathews in the assembly and preliminary operation of this apparatus is acknowledged.

#### **REFERENCES**

1. U. S. Naval Civil Engineering Laboratory Technical Note N-549: Accelerated testing of paints, by P. J. Hearst, Port Hueneme, California, December 1963.
2. U. S. Naval Air Engineering Center Report No. NAEC-AML-2090. The Development Thin Film Preservative Compounds, December 1964.
3. U. S. Naval Air Engineering Center, Report No. NAEC-AML-2436, Development of an Environmental Wet Test Chamber for Simulating Carrier Deck and Other Corrosive Environments, May 1966.

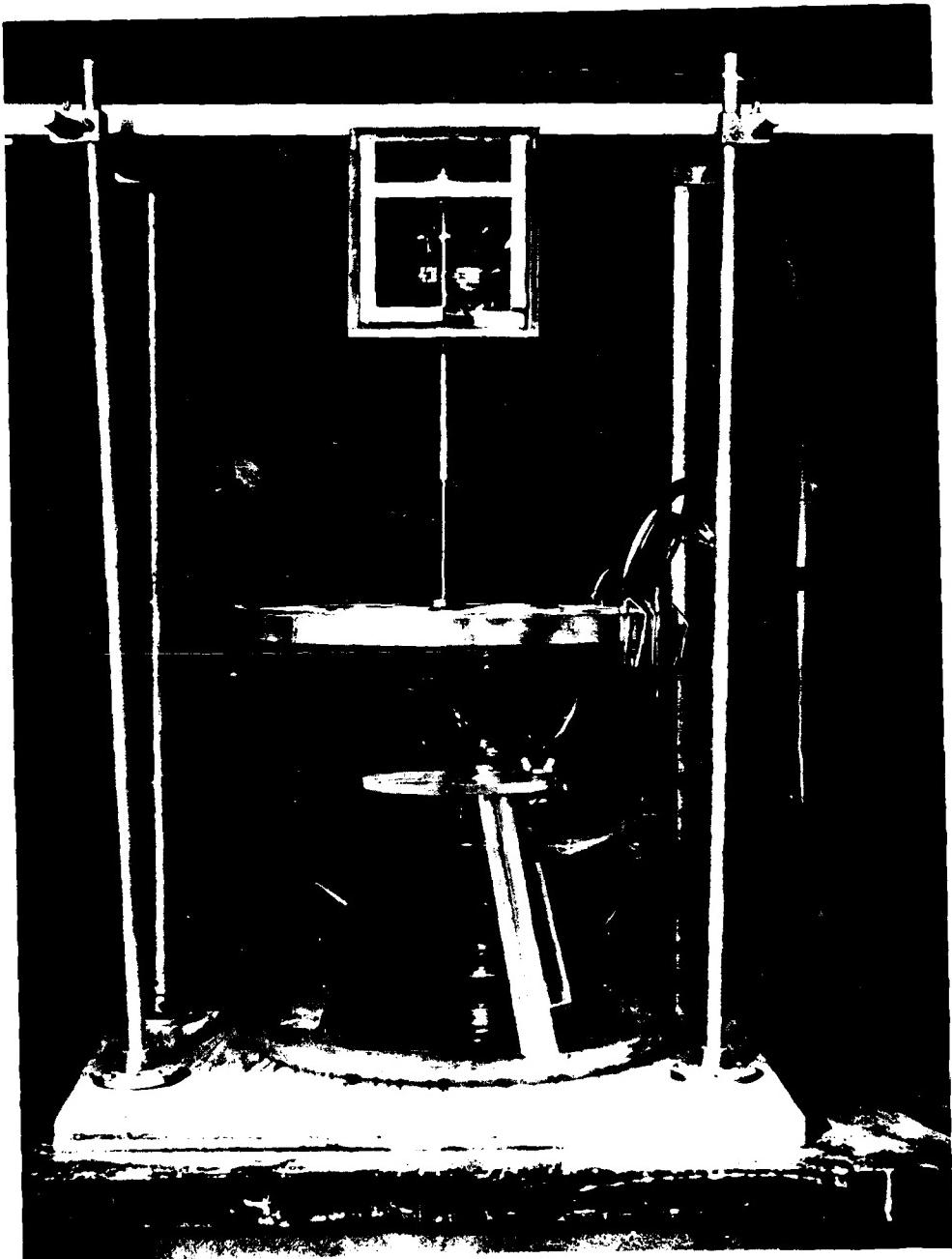


Figure 1. Environmental Test Apparatus.

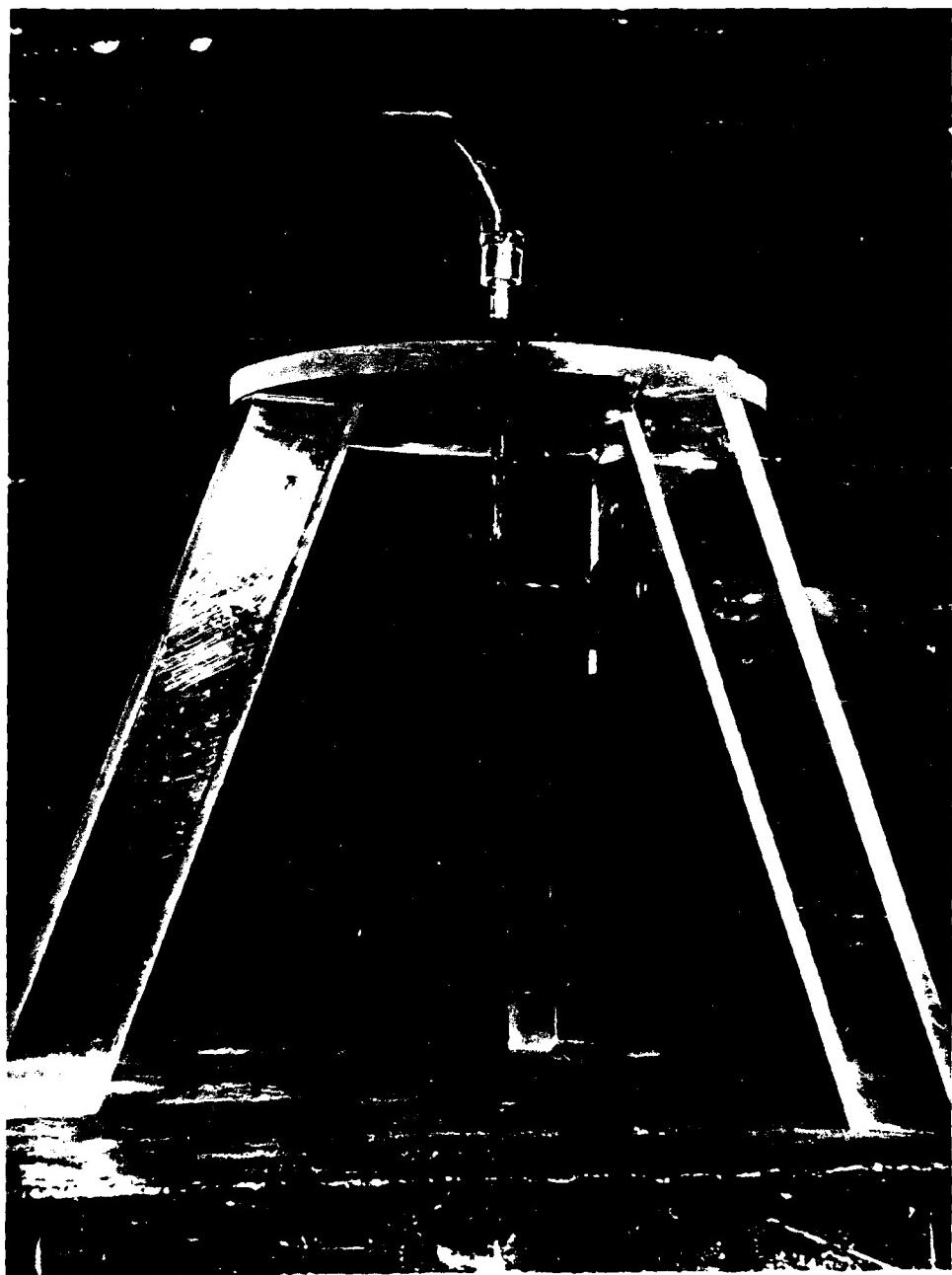


Figure 2. Tripod stand and spray nozzle.

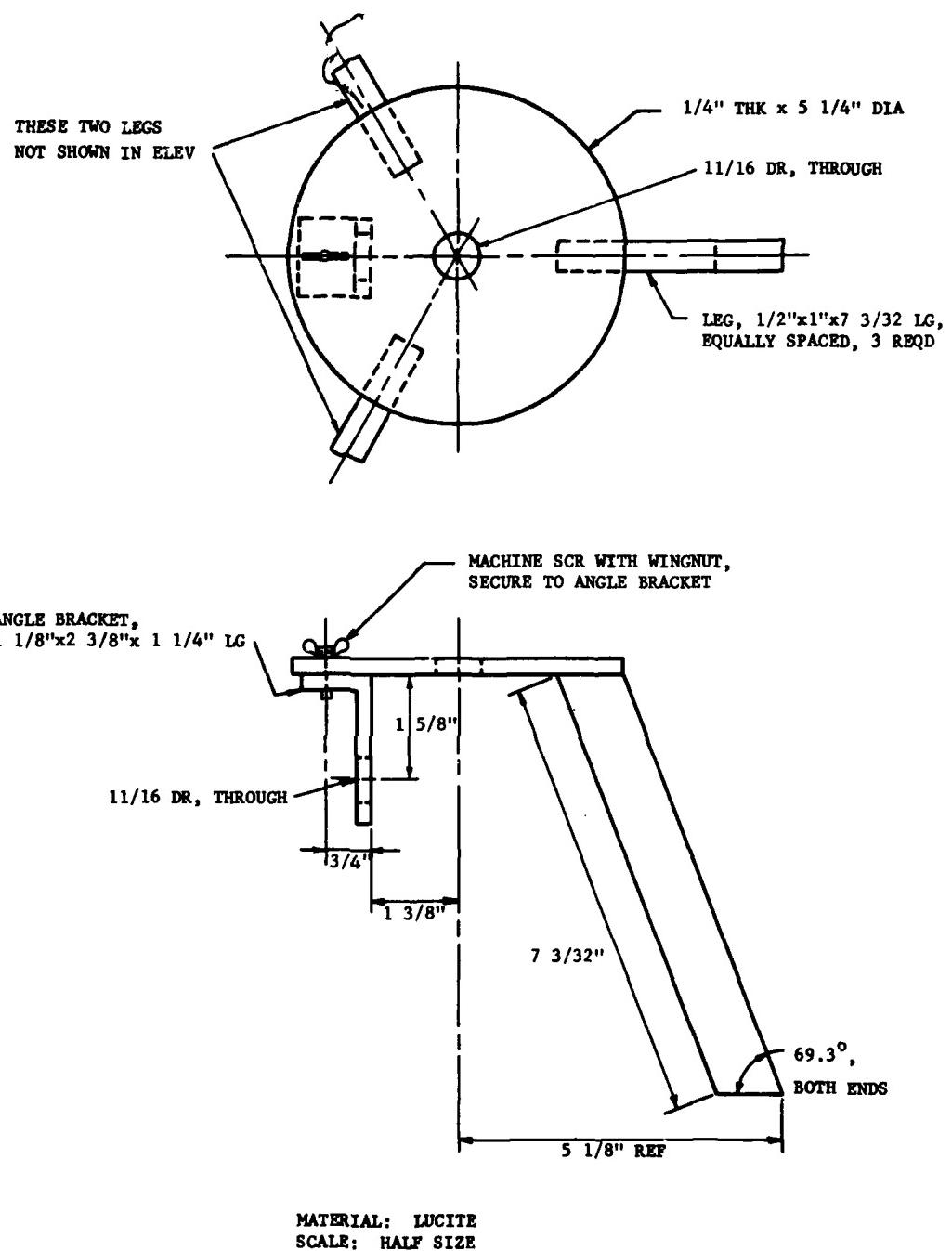


Figure 3. Dimensions of tripod stand.

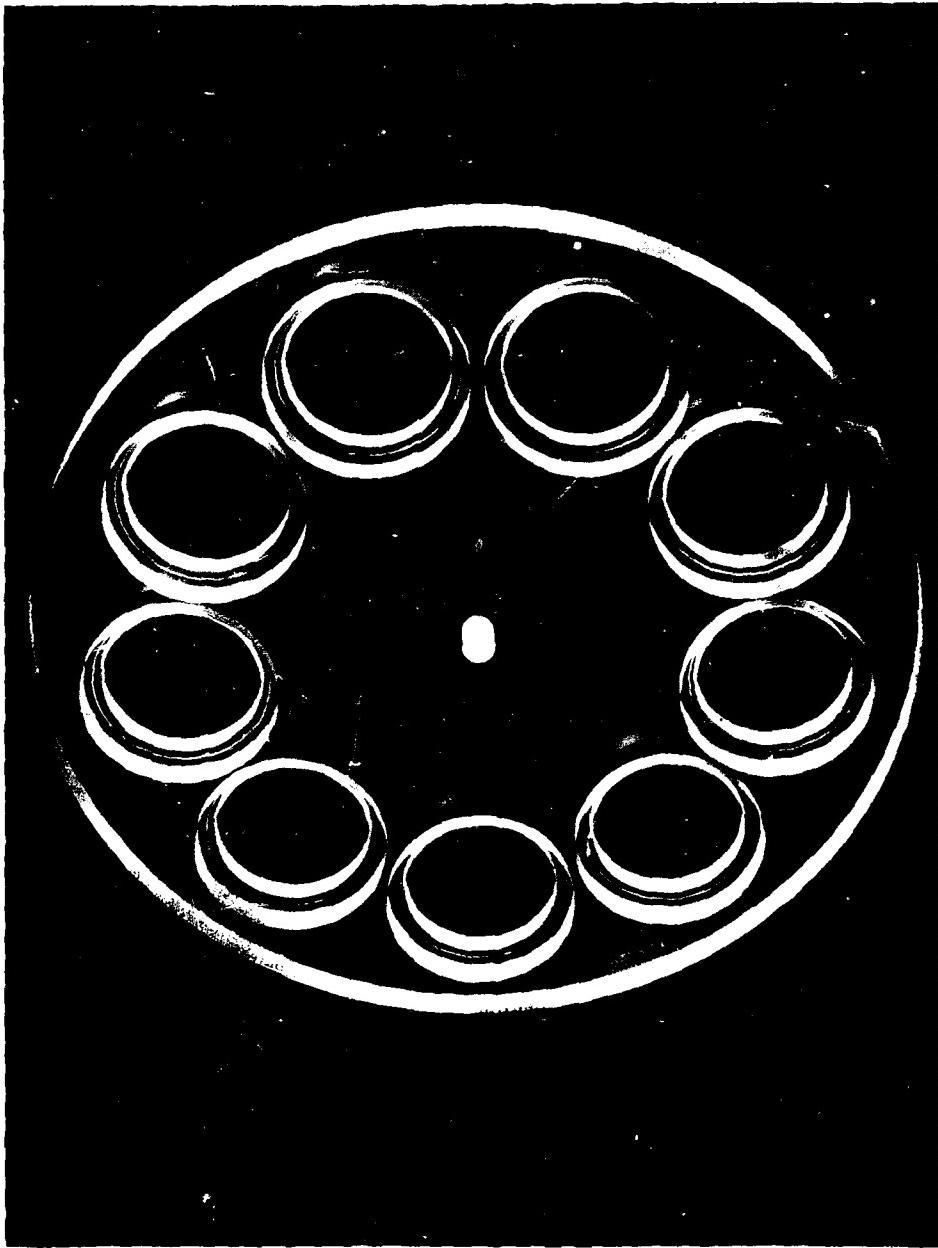


Figure 4. Turntable.

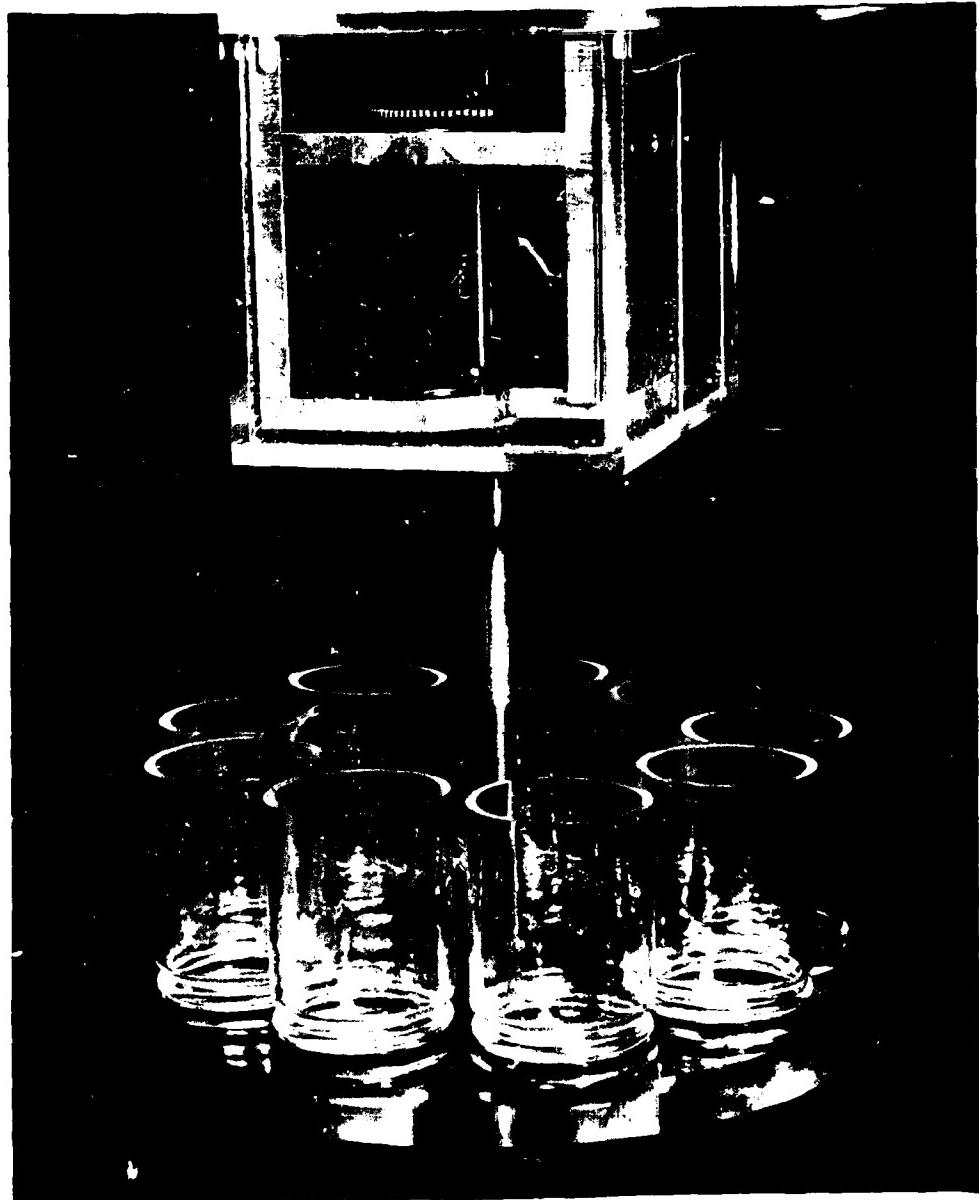


Figure 5. Specimen holders mounted in turntable.

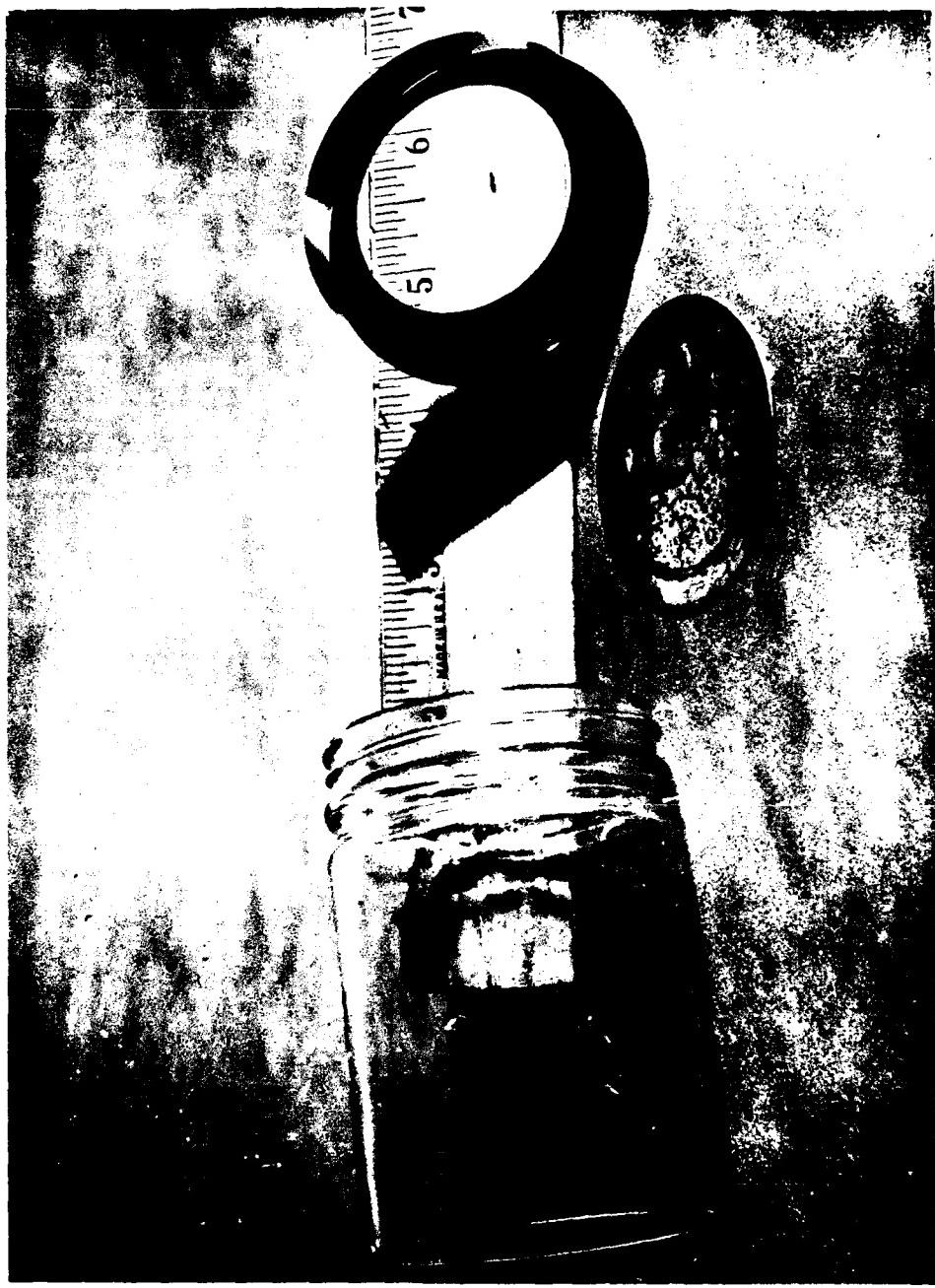


Figure 6. Specimen holder and a specimen.

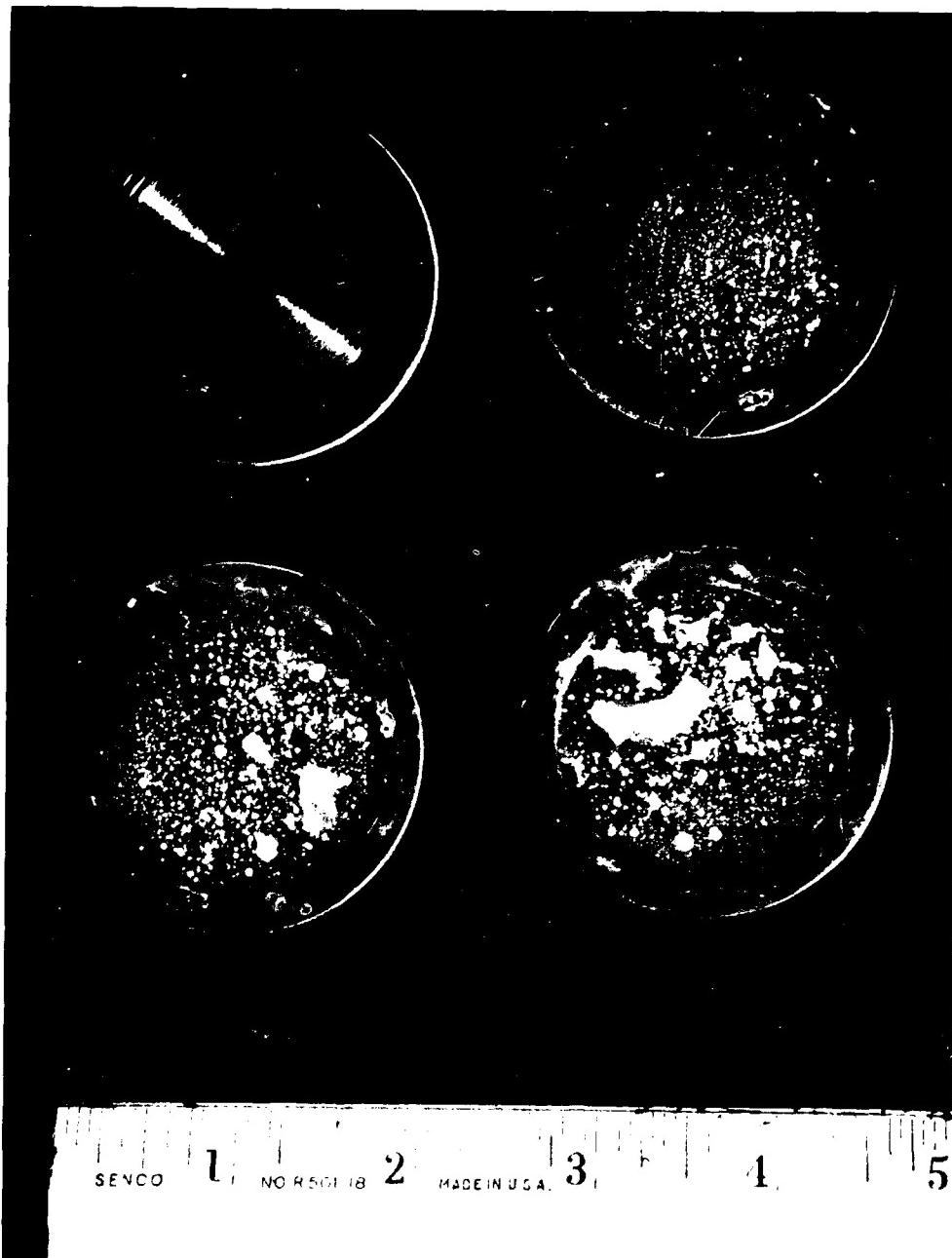


Figure 7. Mild steel specimens after exposure to a salt spray atmosphere - exposure times of 0, 1, 2, and 3 hours.

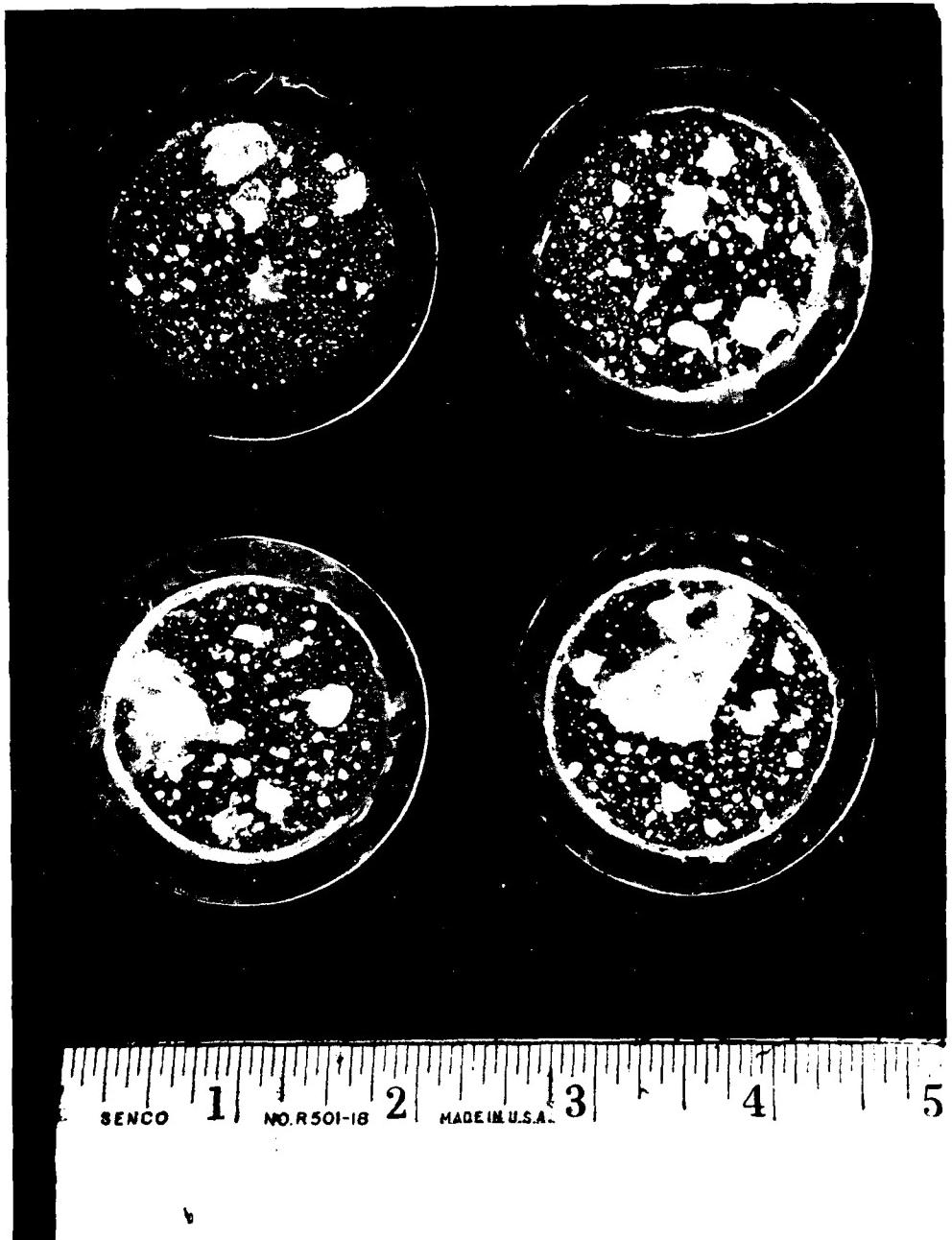


Figure 8. Mild steel specimens after exposure to a salt spray atmosphere - exposure times of 4, 5, 6, and 7 hours.

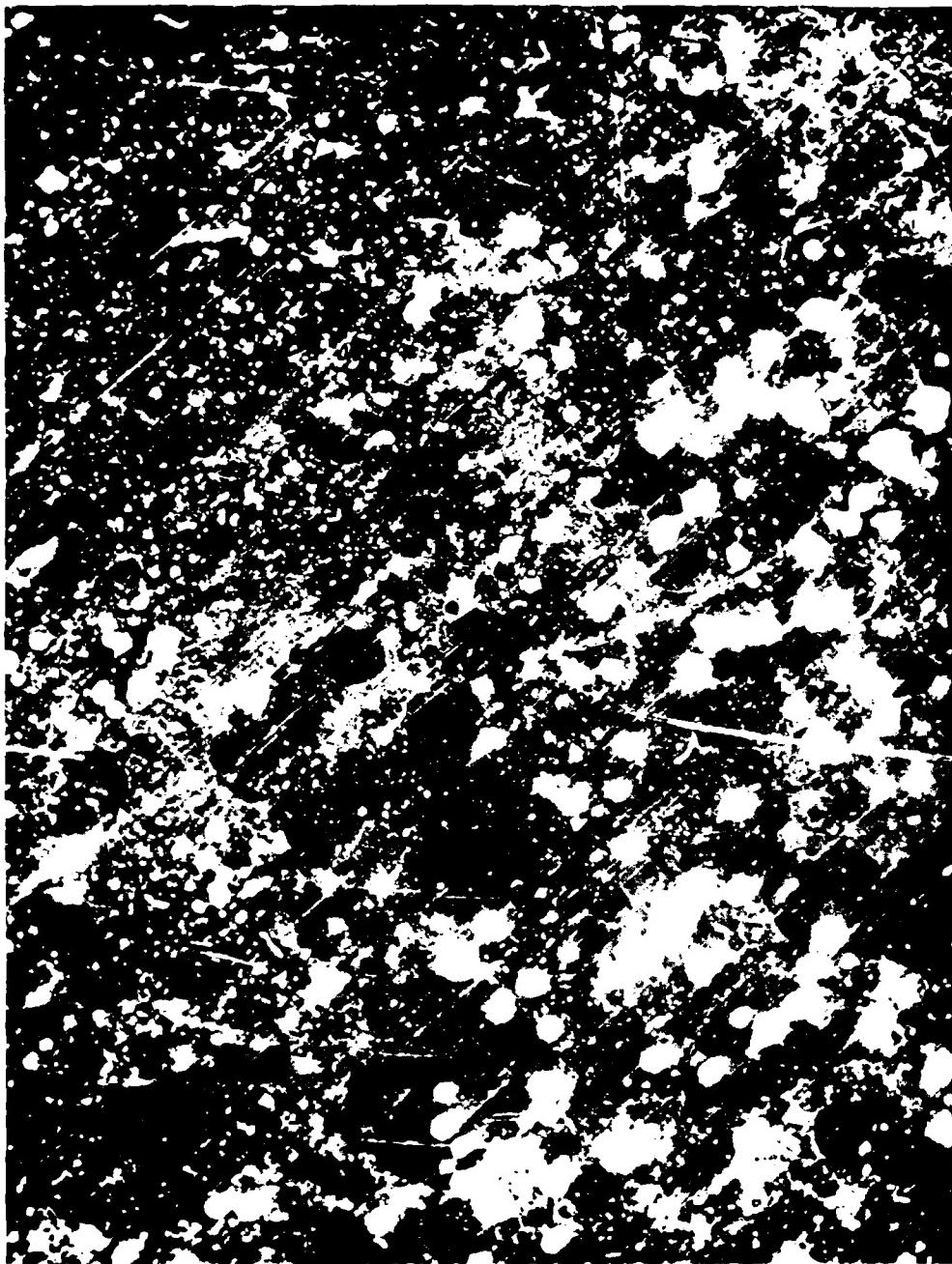


Figure 9. Photomicrograph of mild steel specimen after exposure  
to a salt spray atmosphere for 1 hour.  
Magnification: 3X

UNCLASSIFIED

Security Classification

**DOCUMENT CONTROL DATA - R&D**

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

**DD FORM 1 JAN 64 1473 0101-807-6800**

**UNCLASSIFIED**

Security Classification

## UNCLASSIFIED

## Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Environmental Engineering Steels Testing Equipment Chambers Marine Atmospheres Coatings						
<b>INSTRUCTIONS</b>						
1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization ( <i>corporate author</i> ) issuing the report.	imposed by security classification, using standard statements such as:					
2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.	(1) "Qualified requesters may obtain copies of this report from DDC."					
2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.	(2) "Foreign announcement and dissemination of this report by DDC is not authorized."					
3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.	(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through ."					
4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.	(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through ."					
5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.	(5) "All distribution of this report is controlled. Qualified DDC users shall request through ."					
6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.	If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.					
7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.	11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.					
7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.	12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring (paying for) the research and development. Include address.					
8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.	13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.					
8b. & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.	It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).					
9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.	There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.					
9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers ( <i>either by the originator or by the sponsor</i> ), also enter this number(s).	14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, roles, and weights is optional.					
10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those						

UNCLASSIFIED

Security Classification